



U.S. NUCLEAR REGULATORY COMMISSION

# STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

## 11.1 SOURCE TERMS

### REVIEW RESPONSIBILITIES

Primary - ~~Effluent Treatment Systems Branch (ETSB)~~ Plant Systems Branch (SPLB)<sup>1</sup>

Secondary - None

#### I. AREAS OF REVIEW

At the construction permit (CP) or standard design certification<sup>2</sup> stage of review, ~~ETSB-SPLB~~<sup>3</sup> reviews the information in the applicant's safety analysis report (SAR) on the sources of radioactivity that are input to the radioactive waste management systems for treatment of liquid and gaseous wastes. At the operating license (OL) or combined license (COL)<sup>4</sup> stage of review, ~~ETSB~~ the SPLB review consists of confirming the information accepted at the CP or standard design certification<sup>5</sup> stage.

1. ~~ETSB~~ The SPLB review of radioactive source terms includes consideration of parameters used to determine the concentration of each isotope in the reactor coolant; fraction of fission product activity released to the reactor coolant; concentrations of all nonfission product radioactive isotopes in the reactor coolant; leakage rates and associated fluid activity for all potentially radioactive water and steam systems; and potential sources of radioactive materials in effluents that are not considered in the applicant's safety analysis report (SAR) Section 11.2, "Liquid Waste Management Systems," and SAR Section 11.3, "Gaseous Waste Management Systems." The following sources are considered in the evaluation of effluent releases:
  - a. Boiling water reactor (BWR) gaseous wastes (noble gases, radioiodine, and particulates, carbon-14 and tritium), consisting of offgases from the main

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#### USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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condenser evacuation and turbine gland sealing systems, steam and liquid leakage to containment, radwaste, turbine, fuel handling and auxiliary buildings, and ventilation system exhausts from buildings having the potential for containing radioactive materials.

- b. BWR liquid wastes, consisting of leakage to equipment and floor drains from buildings housing equipment and components that may contain radioactive fluids; contaminated liquids produced by plant operations, such as demineralizer regenerants and resin sluice water, filter backwashes, ultrasonic resin cleaning rinses, decontamination solutions, and laboratory samples and rinses; and detergent wastes.
  - c. Pressurized water reactor (PWR) gaseous wastes (noble gases, radioiodine, and particulates, carbon-14 and tritium), consisting of offgases from the steam generator blowdown flash tank; offgases from the main condenser evacuation system; leakage to containment, fuel handling, auxiliary, and turbine buildings; noble gases stripped from the primary coolant during normal operation and at shutdown; and cover and vent gases from tanks and equipment containing radioactive material.
  - d. PWR liquid wastes, consisting of primary coolant processed to control boron concentration (shim bleed); leakage collected in equipment and floor drains from buildings housing equipment and components that may contain radioactive fluids; steam generator blowdown; condensate demineralizer regenerant solutions; contaminated liquids from anticipated plant operations such as resin sluices, filter backwashes, decontamination solutions, and sample station drains; and detergent wastes.
2. The releases of radioactive materials in liquid and gaseous effluents calculated by ~~ETSB~~ **SPLB** will be used in **Standard Review Plan (SRP)**<sup>6</sup> Sections 11.2 and 11.3 to evaluate the liquid and gaseous waste systems.

## II. ACCEPTANCE CRITERIA

~~ETSB~~ **The SPLB** will accept the source terms used as the design basis for expected releases if the following Commission regulations are met:

- 1. 10 CFR Part 20 as it relates to radioactivity in effluents to unrestricted areas.
- 2. 10 CFR Part 50, Appendix I as it relates to the numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as is reasonably achievable" (**ALARA**) given in the Appendix I.<sup>7</sup>
- 3. General Design Criterion 60 (**GDC 60**)<sup>8</sup> as it relates to the radioactive waste management systems being designed to control releases of radioactive materials to the environment.

The requirement of the Commission regulations identified above are met by using the regulatory positions contained in the following regulatory guides:

- a. Regulatory Guide 1.110 as it relates to the cost-benefit analysis for radioactive waste management systems and equipment.
- b. Regulatory Guide 1.112 as it relates to the method of calculating release of radioactive materials in effluents from nuclear power plants.
- c. Regulatory Guide 1.140<sup>9</sup> as it relates to the design, testing and maintenance of normal ventilation exhaust systems air filtration and adsorption units<sup>10</sup> at nuclear power plants.

Specific criteria necessary to meet the relevant requirements of 10 CFR Part 20 and 10 CFR Part 50 are as follows:

1. The parameters used to calculate primary and secondary coolant concentrations for PWRs are consistent with those given in NUREG-0017. The parameters used to calculate coolant concentrations for BWRs are consistent with those given in NUREG-0016.
2. All normal and potential sources of radioactive effluent delineated in subsection I are considered.
3. For each source of liquid and gaseous waste considered in subsection I.1, the volumes and concentrations of radioactive material given for normal operation and anticipated operational occurrences are consistent with those given in NUREG-0016 or NUREG-0017.
4. Decontamination factors for inplant control measures used to reduce gaseous effluent releases to the environment, such as iodine removal systems and high-efficiency particulate air (HEPA) filters for building ventilation exhaust systems and containment internal cleanup systems are consistent with those given in Regulatory Guide 1.140. The building mixing efficiency for containment internal cleanup is consistent with NUREG-0017.
5. Decontamination factors for inplant control measures used to reduce liquid effluent releases to the environment, such as filters, demineralizers and evaporators, are consistent with those given in NUREG-0016 or NUREG-0017.
6. Radwaste augments used in the calculation of effluent releases to the environment are consistent with the findings of a cost-benefit analysis, performed using the guidance of Regulatory Guide 1.110. The provisions that require a cost-benefit analysis are stated in Section II.D of Appendix I to 10 CFR Part 50.
7. ~~The source terms meet the "as low as is reasonably achievable" objective for effluent releases as required by paragraph c of Section 20.1 of 10 CFR Part 20 (Ref. 6).~~ Effluent

concentration limits at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to 10 CFR Part 20.<sup>11</sup>

8. The source terms result in meeting the design objectives for doses in an unrestricted areas as set forth in Appendix I to 10 CFR Part 50.<sup>12</sup>
9. For evaluating the source terms, the applicant should provide the relevant information in the SAR as required by 10 CFR Part 50, Section 50.34 and 10 CFR Part 50, Section 50.34a. This technical information should include all the basic data listed in Appendix A (BWRs) and Appendix B (PWRs) to Regulatory Guide 1.112 required in calculating the releases of radioactive material in liquid and gaseous effluents (the source terms). An acceptable method for satisfying the criteria given in items 1 through 6 consists of using the Gaseous and Liquid Effluent (GALE) Computer Code and the source term parameters given in NUREG-0016 or NUREG-0017 for BWRs and PWRs respectively. Complete listings of the GALE Computer Codes for BWRs and PWRs are given in NUREG-0016 and NUREG-0017 respectively.
10. If the applicant's calculational technique or any source term parameter differs from that given in NUREG-0016 and NUREG-0017, they should be described in detail and the bases for the methods and parameters used should be provided.

#### Technical Rationale

The technical rationale for application of these acceptance criteria to reviewing the liquid radwaste treatment system is discussed in the following paragraphs:<sup>13</sup>

1. 10 CFR Part 50, Appendix I, provides numerical guidance on offsite individual doses and air doses due to effluents. It also provides an acceptance criterion for cost-benefit analysis as it relates to population doses due to liquid and gaseous effluents (Section II.D of Appendix I). Conformance with Section II.D of Appendix I demonstrates that the plant design includes all items of established modern technology for reducing the cumulative population dose due to releases of radioactive materials from the reactor to ALARA levels of Appendix I.

The calculations using the Gaseous and Liquid Effluent (GALE) Computer Code and the source term parameters given in NUREG-0016 and NUREG-0017 for BWRs and PWRs, respectively, take into account modern technology and the availability of equipment based on that technology to reduce the liquid and gaseous waste management system source terms. The assumptions used in the calculations that are based on the performance of modern equipment have a driving influence on the design parameters used for the radwaste management systems reviewed in SRP Section 11.2, "Liquid Waste Systems," and in Section 11.3, "Gaseous Waste Systems."

Meeting the source term calculation requirements of SRP Section 11.1 provides assurance that the system designs reviewed in SRP Sections 11.2 and 11.3 will meet the effluent concentration limits in unrestricted areas specified in 10 CFR Part 20, the requirements and ALARA objectives of 10 CFR 50.34a as it relates to adequacy of

design information for radwaste management systems; General Design Criteria 60 and 61 of 10 CFR Part 50, Appendix A; and the public dose limitations of 10 CFR Part 50, Appendix I.<sup>14</sup>

2. Compliance with GDC 60 requires that the nuclear power unit design shall include suitable means to control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences.

GDC 60 specifies that the radwaste processing systems provide for a holdup capacity sufficient to retain the radioactive waste, particularly where unfavorable site environmental conditions may impose unusual operational limitations on the release of the effluent. The holdup capacity also provides time to allow the shorter lived isotopes a chance to decay before they are further processed or released to the atmosphere. The holdup times are used in the source term calculations provided for in NUREG-0016 and NUREG-0017.

Meeting the requirements of GDC 60 provides assurance that releases of radioactive materials during normal operation of the radwaste processing systems and during anticipated transients will not result in offsite radiation doses exceeding the limits specified in 10 CFR Part 50, Appendix I, and the effluent concentration limits in unrestricted areas exceeding the limits specified in 10 CFR Part 20.<sup>15</sup>

### III. REVIEW PROCEDURES

The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. In the review of the mathematical models and parameters given in the SAR to calculate primary coolant concentrations, and of the leakage rates to the radioactive waste management systems, ~~ETSB-SPLB~~ compares parameters and calculations given in the SAR with the models and parameters given in NUREG-0016 and NUREG-0017. If the SAR includes models or parameters to estimate reactor coolant concentrations and leakage rates that differ from these reports, the parameters and calculations used need to be substantiated. The preferred method of substantiation is by presentation of operating data from similar reactors.
2. ~~ETSB~~-The SPLB performs an independent calculation of the primary and secondary (PWR) coolant concentrations and of the release rates of radioactive materials using the GALE Computer Code, and the "Principal Parameters for Source Term Calculations" given in NUREG-0016 and NUREG-0017, and the information supplied by the applicant in accordance with Appendices A and B of Regulatory Guide 1.112.
3. In the calculation, ~~ETSB~~-the SPLB will use the applicant's values as given in the SAR for the following parameters: design core thermal power level, steam flow rate, coolant mass, and coolant purification rates.

4. ~~ETSB~~The SPLB will use the coolant concentrations, leakage rates, and effluent release rates calculated above as inputs for evaluation of the liquid waste system, under SRP Section 11.2, and the gaseous waste systems, under SRP Section 11.3, to determine if these systems meet the dose design objectives of Appendix I to 10 CFR Part 50.
5. The ~~ETSB~~SPLB will review under SRP Section 11.5 "Process and Effluent Radiological Monitoring and Sampling Systems," the monitoring and control provisions for all the applicable effluent release points identified in subsection I.1, above.
6. The ~~ETSB~~SPLB source term calculations are used for both the review of the SAR and for the staff's Environmental Impact Statement.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.<sup>16</sup>

#### IV. EVALUATION FINDINGS

Sufficient information has been provided by the applicant so that the requirements of 10 CFR Part 50, Sections 50.34 and 50.34a have been met. The ~~ETSB~~SPLB summary statement on the acceptability of source terms used as design parameters for the waste management systems will be made under SAR Sections 11.2, "Liquid Waste Systems," and 11.3, "Gaseous Waste Systems."

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.<sup>17</sup>

#### V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.<sup>18</sup> Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.<sup>19</sup>

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs.

## VI. REFERENCES

1. NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWRs)," current revision.<sup>20</sup>
2. NUREG-0016, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWRs)," current revision.<sup>21</sup>
3. Regulatory Guide 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."
4. Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors."
5. 10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."
6. 10 CFR Part 20, "Standards for Protection Against Radiation."
7. 10 CFR Part 50, Section 50.34, "Domestic Licensing of Production and Utilization Facilities - Contents of Applications; Technical Information."
8. 10 CFR Part 50, Section 50.34a, "Domestic Licensing of Production and Utilization Facilities - Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors."
9. Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluent from Light-Water-Cooled Power Reactors."
10. 10 CFR Part 50, Appendix A, General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."
11. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel storage and handling and radioactivity control."<sup>22</sup>
- ~~11. 10 CFR Part 50, Appendix A, General Design Criterion 64, "Monitoring Radioactivity Releases."<sup>23</sup>~~

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**SRP Draft Section 11.1**  
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and acronym	Changed PRB to Plant Systems Branch (SPLB).
2.	SRP-UDP format item	Added reference to standard design certification stage of review.
3.	Current PRB acronym	Changed PRB to SPLB (global change for this section).
4.	SRP-UDP format item	Added reference to combined license (COL) review.
5.	SRP-UDP format item	Added reference to standard design certification stage of review.
6.	Editorial	Defined SRP.
7.	SRP-UDP format item and PRB comment	Added acronym for "ALARA."
8.	SRP-UDP format item	Added abbreviation for GDC 60.
9.	SRP-UDP format item and PRB comment C3	Added recommendation that RG 1.140 should be updated.
10.	PRB Comment	Added "air filtration and adsorption units" at the request of the PRB.
11.	Current 10 CFR 20 update item and PRB comment C4	Editorial change made at request of PRB.
12.	PRB comment C5	PRB requested that "unrestricted area" be made plural.
13.	SRP-UDP format item	"Technical Rationale" heading and lead-in sentence added to ACCEPTANCE CRITERIA and organized in numbered form to incorporate the bases for the acceptance criteria.
14.	SRP-UDP format item and PRB comment C6 and C7	Added technical rationale for 10 CFR Part 50, Appendix I.
15.	SRP-UDP format item and PRB comment C8	Added technical rationale for GDC 60.
16.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
17.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.

**SRP Draft Section 11.1**  
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
18.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
19.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
20.	SRP-UDP format item	Changed to indicate that current revision should be used.
21.	SRP-UDP format item	Changed to indicate that current revision should be used.
22.	Editorial	PRB staff added GDC 61 to the technical rationale for 10 CFR Part 50, Appendix I, thereby creating the need to add GDC 61 to the list of references.
23.	SRP-UDP format item	Changed to delete unused reference.

**SRP Draft Section 11.1**  
Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
	No Integrated Impacts were incorporated in this SRP Section.	